Uranium Occurrence and NSF/ANSI Standards for POU Systems.

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U.S. EPA Office of Research and Development

14 Annual EPA Drinking Water Workshop

Cincinnati, OH

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Topics

1. Uranium Chemistry Overview
2. Uranium Occurrence
3. POU NSF/ANSI Standards

Three decay series

Uranium
Thorium
Actinium

Rad Chemistry - Uranium

U 238

Uranium series

Alpha emitter

Half life of 4.5×10^9 years

U 234

Uranium series

Alpha emitter

Half life of 2.5×10^5 years

U 235

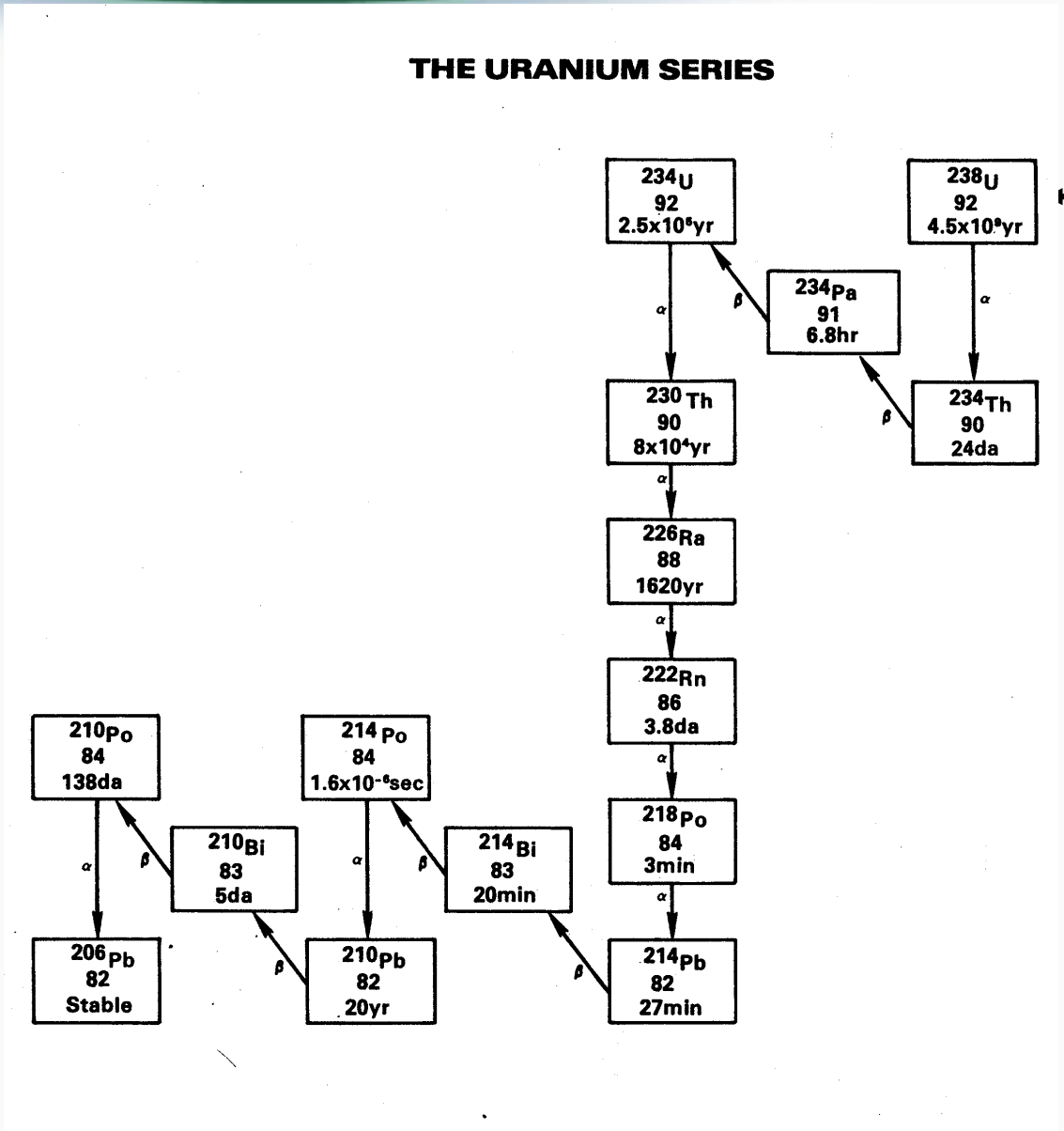
Actinium series

Alpha emitter

Half life of 7.1×10^6 years

Natural Environment
U 238 99.3%
U 234 0.7%
U 235 0.005%

U Chemistry Fundamentals



U 238

U Chemistry Fundamentals

Chemical Concentration in Natural Waters		
Grams	1	
Milligrams	10^{-3}	Ca, Mg, Fe
Micrograms	10^{-6}	As, U
Nanograms	10^{-9}	
Picograms	10^{-12}	Ra

U Chemistry Fundamentals

USEPA Regulated Radionuclides	MCL
Combined Ra -226/228	5 pCi/L
Uranium	30 µg/L
Gross Alpha (excludes U & Rn)	15 pCi/L
Gross Beta	4 mrem/yr

Canada MCL – 20 µg/L

Uranium in water commonly analyzed by ICP-MS

Reported as total U in µg/L

U Chemistry Fundamentals

Gross Alpha - Reported as rad unit - pC/L

MCL – 15 pC/L (excludes U & Rn)

Because U is normally measured by wt, subtracting out the U part of Gross Alpha requires the conversion of U wt measurement to rad unit – pC/L.

Uranium conversion weight unit (ug/L) to rad unit (pCi/L)

True conversion requires an known uranium isotopic distribution (U 238 – U 235 – U234)

Common practice is to assume normal natural occurrence

238 (99.28%); 235 (0.71%); 234 (0.006%)

Result: 1 µg = 0.67 pCi or 30 ug/L = 20 pCi/L

(but this does not hold true for all water)

U Chemistry Fundamentals

Example - Wyoming Water Utility

Gross Alpha – 34.8 pCi/L

Uranium – 27 µg/L
Conversion using 0.67 pCi/ µg/L
Uranium = 18.1 pCi/L

Adjusted Gross Alpha = 34.8-18.1 = 16.7 pCi/L

(Traces of Ra 224, Rn 222; Po 210; Th 230)

Recommendation

Determine uranium isotopes distribution – 2 samples
Result

Correction factors – 1.31 & 1.34 (not 0.67)

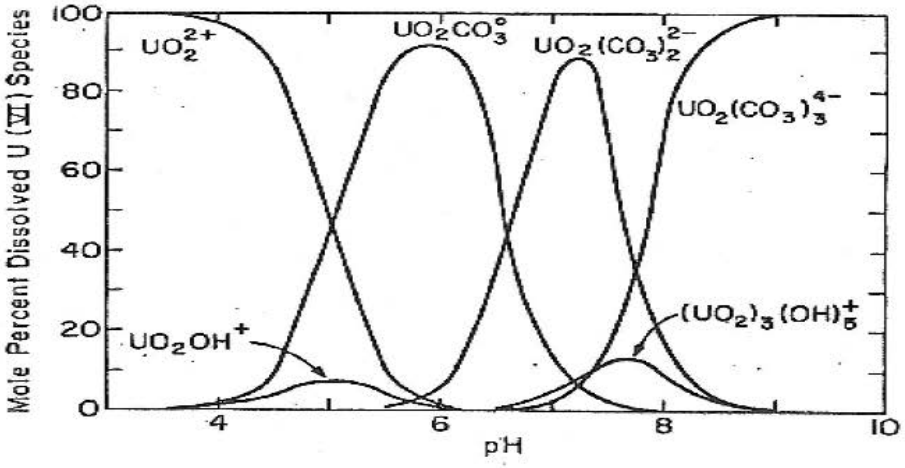
Adjusted Gross Alpha - 29.9pCi/L(18.9x1.31) = 5.1pCi/L

Adjusted Gross Alpha - 29.8pCi/L(16.7x1.34) = 7.4 pCi/L

Uranium - Chemistry

Uranium in water forms uranyl ion - UO^{2+}

that complexes with bicarbonate and carbonate



pH < 2.5 cation – UO^{2+}

pH <2.5 -7 neutral – $UO_2CO_3^0$

pH 7-10 anion – $UO_2(CO_3)_2^{2-}$

$UO2(CO_3)_2^{4-}$

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Uranium Occurrence

USEPA National Inorganics and Radionuclides Survey (NIRS)

Conducted 07/1/1984 to 10/31/1986

Community Water Systems Sampled

Population Category	Sites	Percentage
Very Small (25-500)	716	71.6
Small (501-3,300)	211	21.1
Medium (3,301- 10,000)	47	4.7
Large (10,101 ->100,000	26	2.6
Total	1,000	

Uranium Occurrence

USEPA National Inorganics and Radionuclides Survey (NIRS)

Results

Values > MRL(0.08 µg/L) – 72.2%
Mean – 1.86 µg/L
Maximium – 88.2 µg/L

Uranium Occurrence

2010 USEPA Document

EPA United States Environmental Protection Agency

The Analysis of Regulated Contaminant Occurrence Data from Public Water Systems in Support of the Second Six-Year Review of National Primary Drinking Water Regulations

Office of Water (4607M) EPA-815-B-09-006,
Revised September 2010
www.epa.gov/safewater

Number of States with Data	Total Number of Records	Total Number of Systems	Population Served by Systems
33	41,581	5,921	70,631

Uranium Occurrence

State	U – ug/L 90thID Percentile Ground Water	U – ug/L Maximum Detect		State	U – ug/L 90thID Percentile Ground Water	U – ug/L Maximum Detect
AZ	14.75	**69**		NE	76.56	**252.3**
CA	32.98	**425.37**		NJ	41.79	**380.59**
CO	46.26	**268.65**		NM	39.93	**164.17**
CT	20	**343.87**		NV	33	**294.02**
FL	6.14	21.94		NY	11.7	**150**
IA	16.26	32.23		OR	2.83	36
ID	77.61	**191.04**		RI	42.35	89.01
IL	3.28	18.35		SC	85.03	**127.31**
MA	86.56	183		SD	24.17	28.35
MD	19.1	26.11		TX	40.7	**175.4**
ME	140	**469**		VA	43.13	67.76
MN	4.02	28.95		VT	69.2	87
MO	8.5	23.28		WI	6.56	**104.47**
MT	65	79		WV	27.61	27.61
NC	76.71	**298.5**		WY	27.5	35.2

30 States

Ground Water samples

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Removal of Uranium from Drinking Water

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USEPA Webinar

Cincinnati, OH

February 2, 2016

Uranium NDF/ANSI Standards

NSF/ANSI Standards for Uranium

Status – None

NSF Uranium Task Group created in May 2016

Standards being considered for uranium addition by Uranium Task Group Committee

STD 58 - Reverse Osmosis
STD 62 – Distillation
Std 53 – Health Effects.

Uranium NSF/ANSI Standards

Standards being considered for uranium addition by uranium Task Group Committee

Status

STD 58 Reverse Osmosis Drinking Water Treatment Systems - Proposal approved by TG
Validation testing being conducted by NSF

STD 62 Drinking Water Distillation Systems – Proposal under consideration by TG

STD 53 Drinking Water Treatment Units - Health Effects - Will be considered in future

NSF/ANSI STD 58

Proposed changes to NSF/ANSI 58 for uranium addition.

7.1.2 Inorganic chemical reduction claims

Claims for inorganic chemical reduction may be made for the specific contaminants shown in table 7.2. To qualify for a specific contaminant reduction claim, the system shall reduce the level of the contaminant from the influent challenge level so that the arithmetic mean of all product water sample results and 90% of the individual product water samples is less than or equal to the maximum allowable product water concentration in table 7.2 when tested in accordance with 7.1.2.

Table 7.2 – Contaminant reduction requirements (Addition to Table 7.2)

Contaminant	Individual influent sample point limits mg/L	Average influent challenge level mg/L	Maximum allowable product water level mg/L	USEPA method	Compounds
Uranium	100 µg/L ± 30%	100 µg/L ± 10%	20 µg/L	200.8	$UO_2(NO_3)$
Uranium	400 µg/L ± 30%	400 µg/L ± 10%	20 µg/L	200.8	$UO_2(NO_3)$

Note: Canada MCL = 20 µg/L

NSF/ANSI STD 58

7.1.2.4.1 TDS reduction test water

Chlorine free deionized water shall be used with the following specific characteristics maintained throughout the test:

turbidity	**≤ 1 NTU**
pH	**7.5 ± 0.5**
temperature	**25 ± 1° C (77 ± 2° F)**
conductivity	**1 µS/cm**

Sodium chloride (NaCl) shall be added to the test water to achieve a challenge concentration of 750 ± 40 mg/L TDS.

7.1.2.5 Inorganic substance challenge water (addition to 7.1.2.5)

For pentavalent arsenic, barium, chromium, radium, uranium and perchlorate, the test compound listed in table 7.2 shall be added to the TDS influent challenge water (see 7.1.2.4.1) to achieve the influent concentration specified in table 7.2. For uranium, 50 mg/L Sodium bicarbonate ($NaHCO_3$) shall be added to the test water. The balance of the TDS to achieve the 750 ± 40 mg/L TDS specification above shall be added as Sodium Chloride (NaCl).

Uranium – RO Treatment System ID Project

Treatment System - POE Water Softener + POU RO

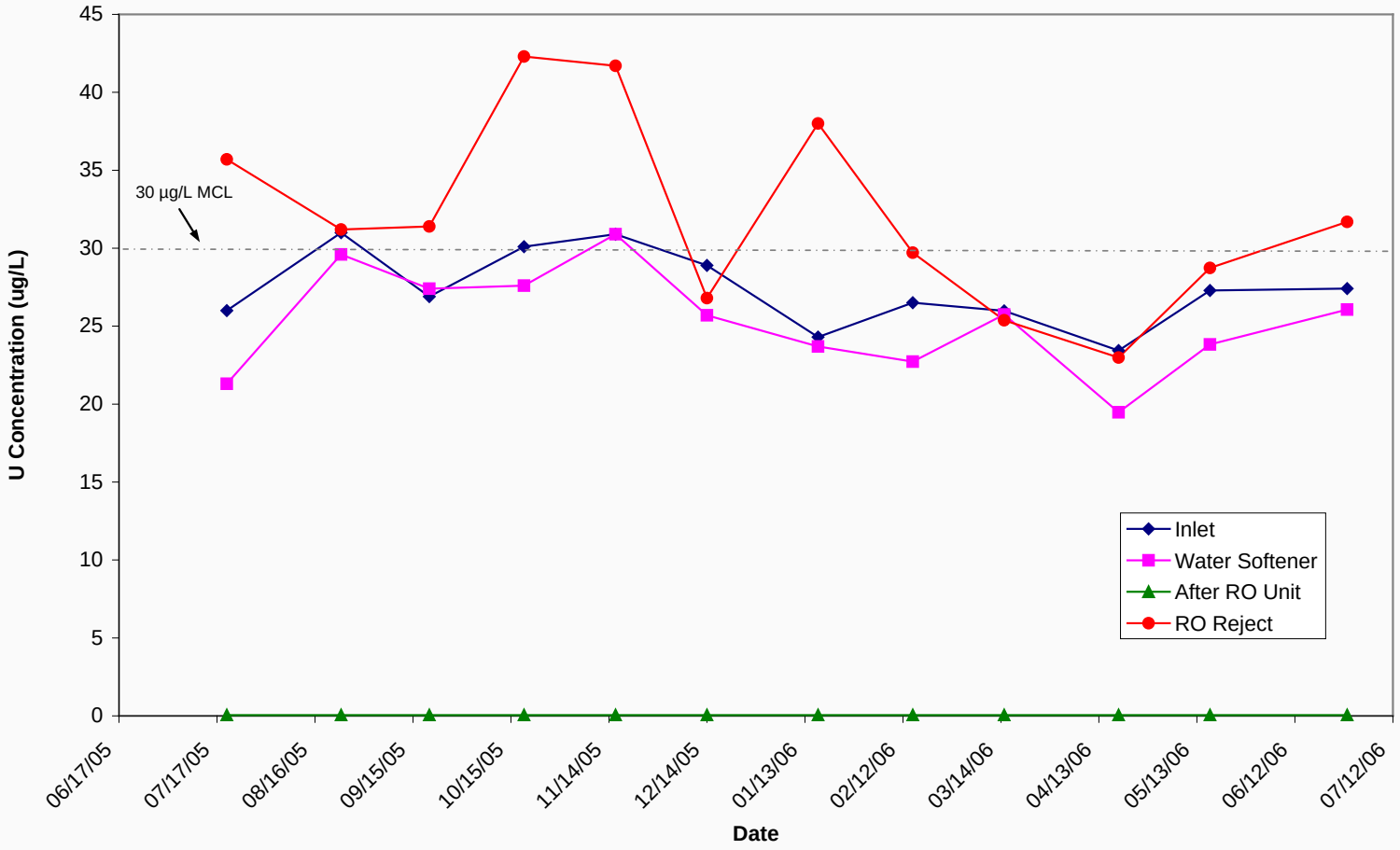
(Well Water: As – 58 µg/L; NO_3(N) - 11 mg/L; U – 27 µg/L; V - 32 µg/L)

(Source: USEPA, Arsenic Demonstration Program)

Uranium – RO Treatment System ID Project

Treatment System - POE Water Softener + POU RO

Treated RO water = U <1 µg/L



EPA RO POU Lab Tests Results

Uranium Influent - µg/L	Percent removal
69	99
182	99

Uranium - Summary

Summary

Not uncommon to have uranium in ground water to be in the 300-500 ug/L.

Currently no NSF/ANSI uranium standard in STDs 53, 58 or 62.

Expect uranium to be added to STDs 58 and 62 some time during the next year.

The End

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